

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

COURSE DESCRIPTION

HVAC/R I is a course that will introduce students to basic to entry-level skills and knowledge related to residential and commercial heating, ventilation, air conditioning, and refrigeration (HVAC/R). Topics covered include tools and equipment, safety, hazards unique to HVAC/R work, physics principles, mechanical refrigeration cycle, and installation and servicing of HVAC/R systems. Course content provides students with skill and knowledge to advance to *HVAC/R II*. Students completing HVAC/R I will be eligible to take the Core, Type I and Type II technician certification of the EPA Proper Refrigerant Usage and Handling examination.

It is strongly recommended that administration and guidance follow the scope and sequence and course recommendations as listed.

Recommended: Construction Core
Algebra I

Recommended Credits: 1

Recommended Grade Level(s): 10th 11th 12th

Number of Competencies in Course: 60

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARDS

- 1.0** Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.
- 2.0** Students will evaluate career opportunities and career paths within the heating, ventilation, air conditioning, and refrigeration industry.
- 3.0** Students will demonstrate the principles of safety and health procedures in the heating, ventilation, air conditioning, and refrigeration industry.
- 4.0** Students will identify, select, use, maintain, and store tools, instruments, and equipment used in the heating, ventilation, air conditioning, and refrigeration industry.
- 5.0** Students will analyze and implement procedures to mitigate hazards associated with heating, ventilation, air conditioning, and refrigeration work.
- 6.0** Students will demonstrate proper refrigerant handling and usage as mandated by Environmental Protection Agency (EPA) Section 608 of the Clean Air Act.
- 7.0** Students will relate the principles of physics to the operation of heating, ventilation, air conditioning, and refrigeration systems.
- 8.0** Students will comprehend and explain the processes involved in the basic mechanical refrigeration cycle.
- 9.0** Students will relate knowledge and skills pertaining to electricity in heating, ventilation, air conditioning, and refrigeration systems.
- 10.0** Students will demonstrate proper soldering, brazing, and piping assembly practices associated with heating, ventilation, air conditioning, and refrigeration industry.
- 11.0** Students will communicate skills required in the heating, ventilation, air conditioning, and refrigeration industry.
- 12.0** Students will demonstrate interpersonal and employability skills required in the heating, ventilation, air conditioning, and refrigeration industry.

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 1.0

Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

LEARNING EXPECTATIONS

The student will:

- 1.1** Cultivate leadership skills.
- 1.2** Participate in SkillsUSA as an integral part of instruction.
- 1.3** Assess situations within the school, community, and workplace and apply values to develop and select solutions.
- 1.4** Demonstrate the ability to work cooperatively with others.
- 1.5** Exhibit integrity and pride in artisanship

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

- 1.1A** Takes initiative in meetings to actively influence the results of deliberations.
- 1.1B** Uses critical-thinking and consensus building skills in group deliberations.
- 1.2A** Applies high ethical standards to personal, community, and professional situations.
- 1.2B** Participates and conducts meetings according to accepted rules of parliamentary procedure.
- 1.3A** Analyzes simulated workplace situations and uses problem-solving and critical-thinking techniques to suggest solutions to the problem.
- 1.3B** Analyzes socio-economic conflicts associated with the construction industry and applies values to evaluate possible ways to mitigate the conflicts.
- 1.4A** Participates in a committee.
- 1.4B** Contributes to a group project.
- 1.5** Exhibits integrity and pride in artisanship.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Create a leadership inventory and use it to conduct a personal assessment.
- Participate in various SkillsUSA or similar programs and/or competitive events.
- Evaluate a civic project within the school, community, and/or workplace and evaluate the expected long term effects of the project.
- Prepare a meeting agenda for a school or community meeting.
- Attend meetings of a related professional organization.

INTEGRATION LINKAGES

SkillsUSA *Professional Development Program (PDP)*, SkillsUSA, Communications and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, English, Algebra, Geometry, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, SCANS (Secretary's Commission on Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), MAVCC, National Center for Construction Education Research (NCCER), United States Department of Labor, United States Department of Labor *Dictionary of Occupational Titles*, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Air Conditioning Contractors of America (ACCA), Refrigeration Service Engineers Society (RSES), Plumbing Heating and Cooling Contractors (PHCC)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 2.0

Students will evaluate career opportunities and career paths within the heating, ventilation, air conditioning, and refrigeration industry.

LEARNING EXPECTATIONS

The student will:

- 2.1** Explain titles, roles, and functions of individuals in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.2** Investigate employment and entrepreneurial opportunities in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.3** Evaluate personal characteristics required for working in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.4** Investigate postsecondary education, professional organizations, and trade publications appropriate for continuing education.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

- 2.1A** Researches occupations within the heating, ventilation, air conditioning, and refrigeration industry.
- 2.1B** Categorizes major responsibilities for each occupation in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.2** Researches and develops a projection of industry trends related to career opportunities in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.3** Profiles personal characteristics that are beneficial to the success of a professional in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.4A** Investigates career options and charts the characteristics of various careers in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.4B** Researches, sets up, and maintains a file outlining professional organizations, current issues, future trends, and emerging technologies in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.4C** Researches and locates information on postsecondary schools that offer heating, ventilation, air conditioning, and refrigeration training.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Categorize employment and entrepreneurial opportunities (listing salary).
- Develop a profile of career opportunities, educational requirements, and projected future employment.
- Develop a personal career plan.
- Appraise professional heating, ventilation, air conditioning, and refrigeration industry organizations and explain their purposes.
- Incorporate professional terminology into conversation.
- Attend meetings of a related professional trade organization.

INTEGRATION LINKAGES

Skills USA, Skills USA *Professional Development Program* (PDP), Manipulative Skills, Research, Communications and Writing Skills, Language Arts, Decision Making Skills, Critical Thinking Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), American Associated Builders and Contractors (ABC), Associated General Contractors (AGC), MAVCC, National Center for Construction Education Research (NCCER), United States Department of Labor, United States Department of Labor *Dictionary of Occupational Titles*, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Air Conditioning Contractors of America (ACCA), Refrigeration Service Engineers Society (RSES), Plumbing Heating and Cooling Contractors (PHCC)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 3.0

Students will demonstrate the principles of safety and health procedures in the heating, ventilation, air conditioning, and refrigeration industry.

LEARNING EXPECTATIONS:

The student will:

- 3.1** Implement safety procedures established by the Environmental Protection Agency (EPA) and Occupational Safety & Health Administration (OSHA).
- 3.2** Analyze and categorize safety and health hazards and their prevention and treatment in the heating, ventilation, air conditioning, and refrigeration industry.
- 3.3** Determine safe and correct procedures for working with electricity in heating, ventilation, air conditioning, and refrigeration.
- 3.4** Exhibit acceptable dress and personal grooming identified by the heating, ventilation, air conditioning, and refrigeration industry.
- 3.5** Use protective clothing, eye protection, and safety equipment.
- 3.6** Demonstrate first aid practices.
- 3.7** Use fire protection equipment.
- 3.8** Comprehend the importance of a safe work environment.
- 3.9** Pass with 100% accuracy a written examination relating specifically to heating, ventilation, air conditioning, and refrigeration safety issues.
- 3.10** Pass with 100% accuracy a performance examination relating specifically to heating, ventilation, air conditioning, and refrigeration tools and equipment.
- 3.11** Maintains a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

- 3.1A** Establishes and maintains a safe and healthy working environment.
- 3.1B** Distinguishes and employs preventive measures of ecological, chemical, and physical contaminants.
- 3.1C** Interprets information from a Material Safety Data Sheet (MSDS).
- 3.1D** Comprehends their responsibilities, regulations, and OSHA policies regarding reporting of accidents and observed hazards, and regarding emergency response procedures.
- 3.1E** Comprehends their responsibilities, regulations, and company policies to protect coworkers and bystanders from hazards.
- 3.2A** Differentiates between hazardous materials, substances, and waste.
- 3.2B** Retrieves MSDSs and identifies the health hazards associated with new materials.
- 3.2C** Reports hazards found on the job site to their supervisor.
- 3.2D** Maintains heating, ventilation, air conditioning, and refrigeration equipment and laboratory in a safe and clean condition.
- 3.2E** Identify and explain Confined Spaces as per the Occupational Safety & Health Administration (OSHA) guidelines.
- 3.2F** Comprehends their responsibilities under HazCom regulations.
- 3.3A** Selects, inspects, and uses the correct instruments for working with electrical equipment and systems.

- 3.3B** Selects, inspects, and uses the correct personal protective equipment for working with electrical equipment and systems.
- 3.3C** Understand and explain the effects of voltage on the human body.
- 3.3D** Erects shields, barriers, and signage to protect coworkers and bystanders prior to starting potentially hazardous electrical tasks.
- 3.4A** Compares and contrasts acceptable dress and personal grooming for specific jobs in the heating, ventilation, air conditioning, and refrigeration industry.
- 3.4B** Demonstrates an understanding of the importance of personal hygiene and cleanliness in work and social environments.
- 3.5A** Selects, inspects, and uses the correct personal protective equipment for the assigned task.
- 3.5B** Inspects, maintains, and employs safe operating procedures with tools and equipment, such as hand and power tools, ladders, and lifting equipment.
- 3.6** Administers simulated basic first aid procedures including treating burns and cuts and electrical shock.
- 3.7A** Identifies the components of fire.
- 3.7B** Identifies the four types of fire extinguishers.
- 3.7C** Explain the proper use of each class of fire extinguisher.
- 3.7D** Explain the PASS method (**P**ull, **A**im, **S**queeze, and **S**weep).
- 3.8A** Continuously is aware of potential hazards to self and others.
- 3.8B** Provides and activates adequate ventilation equipment as required by the task.
- 3.8C** Researches the effects of substance abuse on performance.
- 3.8D** Operates and maintains tools in accordance with manufacturer's instructions and as required by regulation or company policy.
- 3.9** Passes with 100% accuracy a written examination relating specifically to heating, ventilation, air conditioning, and refrigeration safety issues.
- 3.10** Passes with 100% accuracy a performance examination relating specifically to heating, ventilation, air conditioning, and refrigeration tools and equipment.
- 3.11** Maintains a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Conduct a safety and health inspection and identify any potential hazards.
- List causes of most common accidents and outlines a safety prevention program.
- Participate in the Occupational Health and Safety competitions with SkillsUSA.
- Outline a safety management program.
- Develop emergency policies for the heating, ventilation, air conditioning, and refrigeration laboratory.
- Role-play proper procedure for treating burns, cuts, electrical shock treatments according to standards set forth by the American Red Cross.
- Obtain an American Red Cross First Aid Certification and/or CPR Certification.
- Select fire extinguishers for the proper application.
- Demonstrate the PASS method of fire extinguisher use.
- Select, inspect, and use the correct personal protective equipment for the assigned task.
- Inspect power tools for intact guards, shields, insulation, and other protective devices.

- Inspect extension cords for the presence of a functional ground connection, prior to use.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, English, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), MAVCC, National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Power Tool Institute (PTI), National Fire Protection Association (NFPA), Environmental Protection Agency (EPA), United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Air Conditioning Contractors of America (ACCA), Refrigeration Service Engineers Society (RSES), American Red Cross, Plumbing Heating and Cooling Contractors (PHCC)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 4.0

Students will identify, select, use, maintain, and store tools, instruments, and equipment used in the heating, ventilation, air conditioning, and refrigeration industry.

LEARNING EXPECTATIONS

The student will:

- 4.1** Illustrate the function and purpose of heating, ventilation, air conditioning, and refrigeration hand and power tools.
- 4.2** Select meters and instruments of the heating, ventilation, air conditioning, and refrigeration industry for a specific job.
- 4.3** Demonstrate the correct use, storage and care of heating, ventilation, air conditioning, and refrigeration equipment.
- 4.4** Properly maintain and store heating, ventilation, air conditioning, and refrigeration hand tools.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

- 4.1A** Differentiates between common heating, ventilation, air conditioning, and refrigeration hand and power tools.
- 4.1B** Selects the appropriate tool for a given task.
- 4.1C** Demonstrates safety procedures for the use of hand tools and instruments.
- 4.1D** Demonstrates how to use tools to perform maintenance, fabrication, or installation tasks.
- 4.2** Selects and demonstrates the correct use and storage of the following meter and instruments of the heating, ventilation, air conditioning, and refrigeration industry:
 - Compound manifold gauge assembly
 - Digital ammeter
 - Digital volt-Ohm meter
 - Tachometer
 - Digital thermometer
 - Electronic vacuum gauge
 - Manometer
 - Electronic scales
 - Sling psychrometer
 - Digital capacitor analyzer
 - Electronic leak detector
 - Velometer
 - Gas pressure gauge
 - Refractometer
- 4.3A** Selects and demonstrates the correct use and storage of equipment used in the heating, ventilation, air conditioning, and refrigeration industry:
 - Fuel-air torch
 - Oxy-fuel torch
 - Refrigerant recovery machine and cylinders
 - Vacuum pumps

- Charging cylinder
- Schrader valve tool
- Oil pump

4.3B Develops and practices acceptable procedures for the use of shop equipment.

4.4 Follows proper use, care, and maintenance procedures for heating, ventilation, air conditioning, and refrigeration hand tools.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Use hand and power tools without damage to tools or fasteners.
- Set up, adjust, and operate fuel-air and/or oxy-fuel torch.
- Cut, clean, swage, flare, bend and fit tubing according to instructions.
- Test the efficiency of a vacuum pump using an electronic vacuum gauge.
- Set up a refrigerant recovery machine, gauge manifold assembly, recovery cylinder, and demonstrate the proper use.
- Remove control panel(s) and measure the voltage and current draw of an electric motor.
- Measure the resistance of a motor winding.
- Measure the capacitance of a run capacitor.
- Weigh a refrigerant cylinder and test for refrigerant leaks.
- Measure the relative humidity of a given conditioned space.
- Measure the air velocity of a given supply air duct.
- Measure the RPM (revolutions per minute) of a condenser fan motor.
- Measure the manifold pressure of a given gas appliance.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, English, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), SkillsUSA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), MAVCC, National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Power Tool Institute (PTI), Environmental Protection Agency (EPA), Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Air Conditioning Contractors of America (ACCA), Refrigeration Service Engineers Society (RSES), Plumbing Heating and Cooling Contractors (PHCC)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 5.0

Students will analyze and implement procedures to mitigate hazards associated with heating, ventilation, air conditioning, and refrigeration work.

LEARNING EXPECTATIONS

The student will:

- 5.1** Evaluate and mitigate the potential risk of injury from electrical shock, burns, frostbite, and moving parts for a given task.
- 5.2** Use and care for protective equipment for heating, ventilation, air conditioning, and refrigeration workers.
- 5.3** Follow procedures for maintaining a breathable atmosphere when working on heating, ventilation, air conditioning, and refrigeration systems where appropriate.
- 5.4** Handle oxygen, fuel, and inert gas cylinders according to industry practice and regulations.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

- 5.1A** Explains the potential risk of injury from electrical shock for a given task.
- 5.1B** Explains the potential risk of injury from burns and/or frostbite for a given task.
- 5.1C** Explains the potential risk of injury from rotating fans, belts, and shafts for a given task.
- 5.1D** Uses appropriate lockout/tagout procedures when working on heating, ventilation, air conditioning, and refrigeration systems.
- 5.2** Selects, inspects, and uses the correct personal protective equipment, such as gloves, and head, eye, and face protection.
- 5.3A** Describes and demonstrates safety procedures to prevent carbon monoxide poisoning.
- 5.3B** Assesses the air supply and ventilation of combustion processes in equipment.
- 5.3C** Demonstrates knowledge of the hazardous nature of refrigerants of the heating, ventilation, air conditioning, and refrigeration other than CFC and HCFC, such as ammonia, sulfur dioxide, and carbon dioxide, as detailed in the appropriate MSDSs.
- 5.3D** Follows effective procedures for providing adequate ventilation when soldering, brazing, and flushing heating, ventilation, air conditioning, and refrigeration piping in constricted locations.
- 5.3E** Demonstrates safety practices, including Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) requirements for the HVAC/R industry.
- 5.4A** Stores oxygen and fuel gas cylinders in an upright and secured position.
- 5.4B** Operates with oxygen and fuel gas cylinders in an upright and secured position.
- 5.4C** Installs cylinder caps immediately upon removal of gauges from gas cylinders.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Look up MSDSs for designated refrigerants and compressor oils, and describe first aid procedures for accidental exposure to one or more of the substances.
- Demonstrate the proper handling and transportation of oxygen and fuel gas cylinders.
- Explain the risk of injury from electrical shock when measuring current in a compressor motor.
- Given an assignment to complete heating, ventilation, air conditioning, and refrigeration piping requiring soldering or brazing in a small machinery space, have students recommend procedures for supplemental ventilation.
- Given a service task on an existing heating, ventilation, air conditioning, and refrigeration system, use approved lockout/tagout procedure.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, English, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), MAVCC, National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Air Conditioning Contractors of America (ACCA), Refrigeration Service Engineers Society (RSES), Plumbing Heating and Cooling Contractors (PHCC)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 6.0

Students will demonstrate proper refrigerant handling and usage as mandated by Environmental Protection Agency (EPA) Section 608 of the Clean Air Act.

LEARNING EXPECTATIONS

The student will:

- 6.1** Interpret standards as mandated by EPA Section 608 of the Clean Air Act.
- 6.2** Interpret the Clean Air Act and EPA requirements.
- 6.3** Prepare for Core, Type I and Type II technician certification of the EPA Proper Refrigerant Usage and Handling Examination.
- 6.4** Interpret Department of Transportation (DOT) regulations concerning transportation of refrigerants and cylinders.
- 6.5** Recover and recycle refrigerants.

PERFORMANCE INDICATORS: EVIDENCE STANDARDS ARE MET

The student:

- 6.1A** Evaluates the process of refrigerant recovery, recycle, and reclaim.
- 6.1B** Adheres to the rules and regulations set by the Clean Air Act and EPA requirements.
- 6.2A** Researches ozone depletion.
- 6.2B** Comprehends and explains the Montreal Protocol.
- 6.2C** Demonstrates refrigerant recovery, recycling, and reclamation.
- 6.2D** Adheres to an approved disposal system.
- 6.2E** Demonstrates proper labeling and maintains correct and current records.
- 6.2F** Comprehends the procedures and importance of leak detection.
- 6.3A** Evaluates the Significant New Alternatives Policy Program (SNAP).
- 6.3B** Comprehends the benefits and necessity of technician certification.
- 6.4A** Judges the condition of a refrigerant container and determines if refrigerant container is DOT approved and whether it needs to be re-tested.
- 6.4B** Determines if recovery/recycle equipment is certified and meets requirements.
- 6.5** Recover and recycle refrigerants from equipment.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Pass an EPA 608 Refrigerant Usage and Handling Examination Core, Type I and Type II.
- Dispose of empty non-refillable refrigerant cylinder.
- Use recovery equipment and prepare a refrigeration system for disposal.
- Determine whether or not a particular refrigerant recovery cylinder meets DOT approval.
- Label refrigerant cylinder with proper recovered refrigerant designation.
- Demonstrate proper method for transporting refrigerant cylinders and required by DOT.
- Document refrigerant recovered and or used via a sample task.
- Maintain a record of all refrigerant recovery, cylinder inspections, and shipments.
- Demonstrate proper refrigerant recovery and recycling procedures.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, English, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), MAVCC, National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), United States Department of Transportation, Tennessee Department of Transportation, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Air Conditioning Contractors of America (ACCA), Refrigeration Service Engineers Society (RSES), Plumbing Heating and Cooling Contractors (PHCC)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 7.0

Students will relate the principles of physics to the operation of heating, ventilation, air conditioning, and refrigeration systems.

LEARNING EXPECTATIONS

The student will:

- 7.1** Comprehend the concept of temperature and its measurement.
- 7.2** Analyze the concept of specific heat and heat content.
- 7.3** Examine the concept of latent heat associated with change of phase.
- 7.4** Examine the effect of pressure on the boiling point of liquids.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

- 7.1A** Measures temperature and temperature differences.
- 7.1B** Compares and contrasts the concepts of temperature and heat.
- 7.2A** Finds specific heat values for refrigerants and other materials in reference tables.
- 7.2B** Calculates the sensible heat needed to change the temperature of a given amount of refrigerant without a change of state.
- 7.3A** Finds heat of fusion and heat of vaporization for refrigerants and other materials in reference tables.
- 7.3B** Calculates the latent heat needed to change the phase of a given amount of refrigerant.
- 7.4** Examines the relationship between applied pressure and boiling point for common refrigerants.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Monitor and graph the air temperature of an air conditioning duct over the course of several hours.
- On an operating commercial air conditioning system, measure the temperature of the refrigerant piping in a number of locations.
- Monitor and graph the temperature versus time of an ice water mixture as heat is constantly applied until the point where the water boils.
- Monitor the surface temperature of a low-wattage light bulb placed in an air duct with various airflow rates.
- Graph the boiling point versus pressure for common refrigerants.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, English, Algebra, Geometry, Secretary's Commission on

Achieving Necessary Skills (SCANS), SkillsUSA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), MAVCC, National Center for Construction Education Research (NCCER), Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES), Plumbing Heating and Cooling Contractors (PHCC)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 8.0

Students will comprehend and explain the processes involved in the basic mechanical

refrigeration cycle.

LEARNING EXPECTATIONS

The student will:

- 8.1** Analyze the process associated with heat absorption in the evaporator.
- 8.2** Analyze the process associated with heat transfer by the condenser.
- 8.3** Analyze the process that occurs at the metering device.
- 8.4** Analyze the process that occurs at the compressor.
- 8.5** Compare and contrast the properties of common refrigerants.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

- 8.1A** Examines the principle that the refrigerant liquid-gas mixture must be at a lower temperature than the area to be cooled (First Law of Thermodynamics).
- 8.1.B** Examines how large quantities of heat are absorbed when the refrigerant undergoes a phase change (evaporation).
- 8.1C** Comprehends the principle that a low boiling point of the refrigerant is achieved by maintaining a low pressure in the evaporator.
- 8.2A** Examines the principle that the refrigerant liquid-gas mixture must be at a higher temperature than the heat sink (First Law of Thermodynamics).
- 8.2B** Examines the rejection of large quantities of heat when the refrigerant undergoes a phase change (condenses).
- 8.2C** Comprehends the temperature/pressure relationship in the condenser to achieve condensation of the refrigerant.
- 8.3A** Compares refrigerant volume increases and refrigerant pressure as it goes through the metering device.
- 8.3B** Explains that, as a consequence of the reduced pressure, the liquid refrigerant evaporates and drops in temperature.
- 8.4A** Compares refrigerant volume and refrigerant pressure decreases and increases as the compressor compresses it.
- 8.4B** Explains that, as a consequence of the increased pressure, the temperature of the gaseous refrigerant increases.
- 8.5A** Identifies recovered refrigerants by their temperature/pressure characteristics.
- 8.5B** Compares and contrasts the environmental hazards of common refrigerants.
- 8.5C** Examines the refrigeration cycle.
- 8.5D** Explains and calculates a British Thermal Unit (BTU).

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- On an operating commercial refrigeration system, measure the temperature of piping entering and exiting the evaporator and the condenser, and the “high side” and “low side” pressures. Compare to the temperature/pressure charts for the specific refrigerant.
- Make a simplified sketch of a typical refrigeration unit with evaporator, compressor, condenser, and expansion valve. Label the temperatures and pressures measured in the previous task.
- Recover an unknown refrigerant and identify it by matching measured temperature and pressure with reference data.
- Verifies the saturation temperature and pressure of any given refrigerant.
- Prepare a presentation to the class, school, or community group showing examples of conduction, convection, and radiation.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, English, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), MAVCC, National Center for Construction Education Research (NCCER), Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES), Plumbing Heating and Cooling Contractors (PHCC)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 9.0

Students will relate knowledge and skill pertaining to electricity to heating, ventilation, air conditioning and refrigeration systems.

LEARNING EXPECTATIONS

The student will:

- 9.1** Analyze the basic characteristics of electricity.
- 9.2** Apply Ohm's law to heating, ventilation, air conditioning, and refrigeration systems.
- 9.3** Examine electrical circuits and components of heating, ventilation, air conditioning, and refrigeration systems.
- 9.4** Apply basic control wiring and wiring processes used in the heating, ventilation, air conditioning, and refrigeration industry.
- 9.5** Determine the role of electromagnetism as related to motors.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

- 9.1A** Correlates basic electrical concepts with heating, ventilation, air conditioning, and refrigeration.
- 9.1B** Illustrates the concepts of valence, voltage, current, resistance, and voltage drop.
- 9.1C** Compares the two theories of current flow and indicates which theory(s) are used in heating, ventilation, air conditioning, and refrigeration systems.
- 9.1D** Distinguishes between conductor, insulator, and semi-conductor.
- 9.1E** Distinguishes between DC (direct current) and AC (alternating current).
- 9.2A** Deduces the cause and effect relationship in Ohm's law between voltage, current, resistance, and voltage drop.
- 9.2B** Uses Ohm's law to determine values mathematically.
- 9.3A** Analyzes series circuit structure both in application and mathematically.
- 9.3B** Analyzes parallel circuit structure both in application and mathematically.
- 9.3C** Analyzes series-parallel circuit structure both in application and mathematically.
- 9.3D** Differentiates between a short and a ground.
- 9.3E** Compares magnetism and electromagnetism.
- 9.4A** Wires and tests different thermostats used in the heating, ventilation, air conditioning, and refrigeration industry.
- 9.4B** Wires and tests different control circuits and systems used in the heating, ventilation, air conditioning, and refrigeration industry.
- 9.5A** Illustrates electromagnetic induction.
- 9.5B** Compares concepts of magnetism to their electrical counterparts: reluctance to resistance, field distance to voltage, and magnetic force to current.
- 9.5C** Analyzes the role of magnetism and electromagnetic induction in heating, ventilation, air conditioning, and refrigeration systems and motor components.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Use appropriate instruments and meters to measure watts, volts, Ohms, and amps.
- Demonstrate the proper use of an ammeter, ohmmeter, voltmeter, and wattmeter.
- Select appropriate meter to check capacitance.
- Construct series and parallel circuits.
- Select proper fuse or breaker for a given size wire.
- Determine the capacities of a given run capacitor.
- Wire and test electronic thermostats used on heat pump systems, gas furnaces, and air conditioning system.
- Wire and test mechanical thermostats used on refrigeration systems.
- Wire and test defrost control boards used on heat pump system.
- Wire and test defrost controls used on refrigeration systems.
- Wire fan controls and /or control boards used in heat pumps, gas furnaces, and air conditioning systems.
- Identify the different types of electric motors by number of magnetic poles.
- Identify different winding of an electric motor by resistance and size.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, English, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), MAVCC, National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Air Conditioning Contractors of America (ACCA), Service Engineers Society (RSES)), Plumbing Heating and Cooling Contractors (PHCC)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 10.0

Students will demonstrate proper soldering, brazing, and piping assembly practices associated with the heating, ventilation, air conditioning, and refrigeration industry.

LEARNING EXPECTATIONS

The student will:

- 10.1** Safely and properly assemble and set up oxy-fuel and/or fuel air torch systems.
- 10.2** Identify the purpose, types, and uses of different filler alloys used in the heating, ventilation, air conditioning, and refrigeration industry.
- 10.3** Identify the purpose, types, and uses of different fluxes used in the heating, ventilation, air conditioning, and refrigeration industry.
- 10.4** Cut, assemble, and braze/solder, and pressure test piping and joint configurations used in the heating, ventilation, air conditioning, and refrigeration industry.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

- 10.1A** Identifies the components of an oxy-fuel torch.
- 10.1B** Identifies the components of a fuel air torch.
- 10.1C** Demonstrates proper assembly, testing, and lighting of an oxy-fuel torch.
- 10.1D** Demonstrates proper assembly, testing, and lighting of an air fuel torch.
- 10.1E** Demonstrates proper shut down and storage of oxy-fuel torches.
- 10.1F** Demonstrates proper shut down and storage of air fuel torches.
- 10.1G** Explains safety concerns and issues related to oxy-fuel and air fuel torches and their use.
- 10.2A** Explains the difference and uses of phous-copper filler alloys as related to silver content.
- 10.2B** Explains the difference and uses silver brazing alloys as related to silver content.
- 10.2C** Explains the difference and uses in low temperature filler alloys as related to silver content.
- 10.2D** Identifies the solidus and liquidus temperatures of the different filler alloys used in the heating, ventilation, air conditioning, and refrigeration industry.
- 10.2E** Explains safety concerns and issues related to filler alloys and their use.
- 10.3A** Explains the types and purpose of fluxes used with silver brazing alloys.
- 10.3B** Explains the types and purpose of fluxes used with low temperature filler alloys.
- 10.3C** Explains the difference in fluxes used in the heating, ventilation, air conditioning, and refrigeration industry.
- 10.3D** Explains safety concerns and issues related to fluxes and their use.
- 10.4A** Measures, cuts, and fits copper, brass, and steel assemblies per an assigned layout.
- 10.4B** Chooses proper filler alloys and fluxes to join copper, brass, and steel assemblies per an assigned layout.
- 10.4C** Demonstrates proper use of oxy-fuel and/or air fuel torches to assemble copper, brass, and steel assemblies per an assigned layout.
- 10.4D** Pressure tests piping assemblies fabricated by student according to industry standards and guidelines.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Identify components of a oxy-fuel and/or air fuel torch system.
- Explain proper setup for oxy-fuel and/or air fuel torch systems.
- Demonstrate proper setup for oxy-fuel and/or air fuel torch systems.
- Demonstrate proper method and use for oxy-fuel and/or air fuel torch systems.
- Explain and demonstrate safety concerns and issues related to oxy-fuel and air fuel torches and their use.
- Measure, cut, and fit copper, brass, and steel assemblies per instructor's directions.
- Choose proper filler alloys and fluxes to join copper, brass, and steel assemblies.
- Demonstrate proper method and use for oxy-fuel and/or air fuel torch systems in brazing and soldering applications.
- Pressure test piping assemblies fabricated by student according to industry standards and instructor's directions.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, English, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), SkillsUSA, MAVCC, National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Air Conditioning Contractors of America (ACCA), Refrigeration Service Engineers Society (RSES), Plumbing Heating and Cooling Contractors (PHCC)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 11.0

Students will demonstrate communication skills required in the heating, ventilation, air conditioning, and refrigeration industry.

LEARNING EXPECTATIONS

The student will:

- 11.1** Communicate and comprehend oral and written information typically occurring in the heating, ventilation, air conditioning, and refrigeration industry and workplace.
- 11.2** Solve problems and make decisions using a logical process.
- 11.3** Use teamwork skills to accomplish goals, solve problems, and manage conflict within groups.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

- 11.1A** Interprets and uses written information in common job formats, such as tables, charts, and reference materials and manuals.
- 11.1B** Interprets and uses graphical information such as blueprints, electrical schematics, process control schematics, diagrams, and other heating, ventilation, air conditioning, and refrigeration service and installation diagrams.
- 11.1C** Uses electronic resources to obtain service and other heating, ventilation, air conditioning, and refrigeration service and installation information.
- 11.1D** Analyzes information obtained from various sources to determine a diagnostic approach to heating, ventilation, air conditioning, and refrigeration service.
- 11.1E** Communicates clearly and appropriately in oral and written form.
- 11.1F** Interprets a heating, ventilation, air conditioning, and refrigeration repair order.
- 11.1G** Identifies and explains such terms as the following:

Superheat	Sub-cooling
Latent heat	Sensible heat
Refrigerant	Saturation Point
Compression Ratio	TXV (thermostatic expansion valve)
BTU	
- 11.2A** Develops a hypothesis regarding the cause of a heating, ventilation, air conditioning, and refrigeration problem.
- 11.2B** Tests the hypothesis to determine the solution to the heating, ventilation, air conditioning, and refrigeration problem.
- 11.2C** Creates, evaluates, and revises, as needed, a plan to resolve a heating, ventilation, air conditioning, and refrigeration problem.
- 11.3A** Serves in each of the functional roles of a team.
- 11.3B** Resolves conflicts within a group.
- 11.3C** Demonstrates appropriate and positive examples of giving and accepting criticism.
- 11.3D** Modifies behavior or revises work based on appropriate criticism.
- 11.3E** Solves problems in cooperation with other members of a group.
- 11.3F** Evaluates the role of the heating, ventilation, air conditioning, and refrigeration service technician within the organizational system of a dealership or independent shop.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Complete a heating, ventilation, air conditioning, and refrigeration repair order.
- Role-play and analyze methods of conflict resolution.
- Explain written instructions to a fellow student and instructor.
- Explain oral instructions to a fellow student and instructor.
- Create written instructions for a simple task.
- Create oral instructions for a simple task.
- Demonstrate a task following written instructions
- Demonstrate a task following oral instructions.
- Explain the importance of instruction and the need to follow them.
- Create a diagnostic procedure or flow chart based on information gathered from various sources.
- Test a potentially defective heating unit, air conditioning unit, and ventilation unit using a created procedure or flow chart.
- Use blueprints and diagrams to execute a task.
- Research terms typically used in the heating, ventilation, air conditioning, and refrigeration industry and discuss them in class.
- Participate as a team member in a given task or assignment.
- Serve as a team leader in a given task or assignment.
- Research possible evaluation methods used by employers in the heating, ventilation, air conditioning, and refrigeration industry.
- Explain a service diagnosis to a fellow student and instructor.
- Research the role of the heating, ventilation, air conditioning, and refrigeration service technician and present findings in class.
- Explain the importance of written documentation in the heating, ventilation, air conditioning, and refrigeration industry.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, English, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA, MAVCC, National Center for Construction Education Research (NCCER), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Air Conditioning Contractors of America (ACCA), Refrigeration Service Engineers Society (RSES), Plumbing Heating and Cooling Contractors (PHCC)

EATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 12.0

Students will demonstrate interpersonal and employability skills required in the heating, ventilation, air conditioning, and refrigeration industry.

LEARNING EXPECTATIONS

The student will:

- 12.1** Infer relationships between work ethics and organizational and personal job success.
- 12.2** Demonstrate attitudes conducive to workplace success.
- 12.3** Maintain a neat and orderly work area.
- 12.4** Assess implications of diversity for communities and workplaces.
- 12.5** Exhibit positive employability behaviors.
- 12.6** Develop individual time management and work sequencing skills.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

- 12.1A** Illustrates the concept of a “work ethic.”
- 12.1B** Assesses the potential impact of an individual’s work ethic on an organizational system.
- 12.1C** Infers the relationship between work ethics and personal job success.
- 12.2A** Judges which attitudes are conducive to success.
- 12.2B** Modifies behavior to reflect attitudes for success.
- 12.3A** Keeps work area organized and free from clutter.
- 12.3B** Cleans work area according to shop standard.
- 12.3C** Deduces the correlation between a clean orderly work environment and successful and efficient job performance.
- 12.4A** Points out benefits and problems that may arise from diversity in the transportation service workplace.
- 12.4B** Devises solutions to problems arising from diversity.
- 12.5A** Demonstrates proper dress for work in heating, ventilation, air conditioning, and refrigeration industry.
- 12.5B** Demonstrates appropriate grooming for work in heating, ventilation, air conditioning, and refrigeration industry.
- 12.6A** Assesses the benefits of incorporating time management principles into work in the heating, ventilation, air conditioning, and refrigeration industry.
- 12.6B** Displays time management and work sequencing skills in class assignments.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor’s discretion.

- Explain hazards associated with improper dress.
- Explain the importance of arriving at work at the assigned time.
- Explain the importance of honesty and integrity in the workplace.
- Explain multicultural environments and there importance in the workplace.

- Research cultural diversity and equity issues impacting the heating, ventilation, air conditioning, and refrigeration industry.
- Students are divided into groups of four to six. Each group is given a different scenario of a heating, ventilation, air conditioning, and refrigeration industry service workplace situation in which an employee demonstrates a poor work ethic. The group identifies the problem and all the possible ramifications of the individual's behavior for the organization, other employees, and the employee him/herself. Each group then presents its scenario and analysis to the class.
- Explain the importance of community involvement by companies and employees.
- Maintain a clean and safe working environment in all shop and class activities.
- Demonstrate proper time management in assigned activities.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, English, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA, Skills USA *Professional Development Program* (PDP), Associated Builders and Contractors (ABC), Associated General Contractors (AGC), MAVCC, National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Air Conditioning Contractors of America (ACCA), Refrigeration Service Engineers Society (RSES), Plumbing Heating and Cooling Contractors (PHCC)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

SAMPLING OF AVAILABLE RESOURCES

- *Core Curriculum*, National Center for Construction Education and Research (NCCER), Prentice Hall, Upper Saddle River, NJ; ©2000. Also known as the Contren materials.
- *HVAC/R Level One*, National Center for Construction Education and Research (NCCER), Prentice Hall, Upper Saddle River, NJ; ©2001. Also known as the Contren materials.

- *HVAC/R Level Two*, National Center for Construction Education and Research (NCCER), Prentice Hall, Upper Saddle River, NJ; ©1995. Also known as the Contren materials.
- *HVAC/R Level Three* National Center for Construction Education and Research (NCCER), Prentice Hall, Upper Saddle River, NJ; ©1996. Also known as the Contren materials.
- *HVAC/R Level Four*, National Center for Construction Education and Research (NCCER), Prentice Hall, Upper Saddle River, NJ; ©1996. Also known as the Contren materials.
- *Fundamentals of Air Conditioning and Refrigeration*, MAVCC, Oklahoma Department of Vocational and Technical Education ©1996
- *Residential and Light Commercial HVAC*, MAVCC, Oklahoma Department of Vocational and Technical Education ©1998
- *Domestic Refrigerator, Freezer, and Window Air Conditioner Service*, MAVCC, Oklahoma Department of Vocational and Technical Education ©1996
- *ACR Electrical Systems*, MAVCC, Oklahoma Department of Vocational and Technical Education ©1997
- *Oxyacetylene Welding and Oxyfuel Cutting 3rd Edition*, MAVCC, Oklahoma Department of Vocational and Technical Education ©2004
- *Refrigeration & Air Conditioning Technology 4th Edition*, Delmar Thomson Learning, Stamford, CT. ©2000
- *Modern Refrigeration and Air Conditioning*, Goodheart-Willcox Company Inc. Tinley Park, IL. ©2000
- *Heating and Cooling Essentials*, Goodheart-Willcox Company Inc. Tinley Park, IL. ©2003
- *Service Application Manual*, Refrigeration Service Engineers Society, Des Plaines, IL
- *Air Conditioning News*, BNP
- Air Conditioning Refrigeration Institute (ARI), www.ari.org
- Refrigeration Service Engineers Society (RSES), www.rses.org
- *RSES Journal*, RSES
- American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE), www.ashrae.org
- ACCA (Air-Conditioning Contractors Association), www.acca.org

- Plumbing-Heating-Cooling-Contractors (PHCC), www.phccweb.org
- Occupation Safety and Health Administration (OSHA), www.osha.gov
- North American Technician Excellence Inc. (NATE), www.natex.org
- Council of Air Conditioning and Refrigeration Educators (CARE), www.carehvacr.org
- *Total Quality Curriculum*, National SkillsUSA
- Professional Development Program, National SkillsUSA—www.vica.org
- Power Tool Institute, www.powertoolinstitute.com
- Fluke Educators Portal, <http://support.fluke.com/educators>
- **J. W. Harris Co.** www.jwharris.com
- **Various Equipment Manufacturers**